ACTA ARACHNOL., XXVII, (1), 1976

ALTERNATIVE OCCURRENCE OF TWO OVARIAN FUNCTIONS IN THE ADULT PSEUDOSCORPION, *GARYPUS JAPONICUS* BEIER[1)]

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Synopsis

MAKIOKA, Toshiki (Shimoda Marine Biological Station, Tokyo Kyoiku University, Shimoda): Alternative occurrence of two ovarian functions in the adult pseudoscorpion, *Garypus japonicus* BEIER. *Acta Arachnol.*, 27: 8-15 (1976).

A general pattern of occurrence of the oogenic and secretory functions was studied in adult ovaries of the pseudoscorpion, *Garypus japonicus*. Both functions occurred alternatively and caused three morphological types or four functional phases of the ovary to appear. The relations among the morphological types and/or the functional phases were discussed.

In many pseudoscorpions, the occurrence of two different ovarian functions is known, *viz.* the formation of the eggs and the secretion of the nutritive fluid for the embryos and larvae. A few studies have been undertaken on either the former (SAREEN, 1965; BOISSIN et MANIER, 1969/1970; BOISSIN, 1970; WOOD, 1975) or the latter (LUBBOCK, 1861; VACHON, 1938). Besides, on the relationships between both functions, only one study has been reported especially on a complementary trophic relation between the yolk and the nutritive fluid (MAKIOKA, 1968).

The author has been studying the ovary of the pseudoscorpion, *Garypus japonicus*, in order to elucidate the natural and the artificial occurrence of each function. In the present paper, a general pattern of the occurrence of both functions in adult ovaries is reported prior to detailed descriptions.

The author wishes to express his sincere thanks to Dr. Koichi SEKIGUCHI,

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professor of the University of Tsukuba, for his constant encouragement and helpful advice in the course of this work. Thanks are also due to Dr. Hiroshi ANDO, Professor of Tokyo Kyoiku University, for his kindness in reading the manuscript.

Materials and Methods

Adult females of *Garypus japonicus* were collected along the coast at Shimoda in the Izu Peninsula every month through the years from 1972 to 1974. Up to 118 females were dissected immediately after collection to remove the ovaries. On the other hand, some females were reared in the laboratory at a temperature of 25±2°C during the breeding seasons (from June to August). Most of the females constructed the breeding nests in which they laid eggs and nursed embryos and larvae until they left the nests about 5 weeks later. These 114 females were also dissected in order of the embryo-breeding stage in *G. japonicus* (MAKIOKA, 1968 and 1970).[2)]

The removed ovaries were fixed with BOUIN's solution or HEIDENHEIN's Susa solution and prepared as serial paraplast sections 5-8 μm thick. They were stained with MAYER's acid hemalum and eosin, HEIDENHEIN's iron hematoxylin, or HEIDENHEIN's azan.

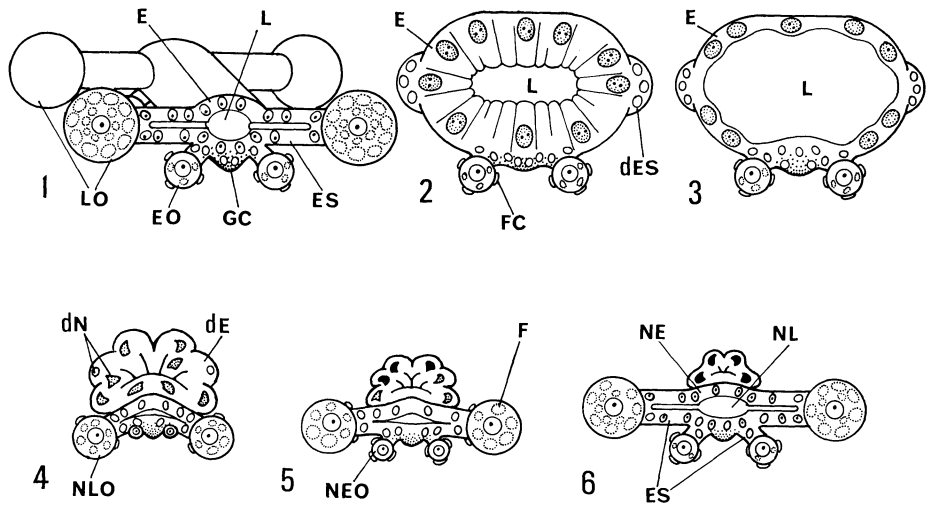
The oocytes and the ovarian epithelial cells were especially observed as the sites where the oogenic and secretory functions occur, respectively.

Observations

In the dissected females, three morphological types of the ovaries, unswollen, swollen, and contracted, were distinguished.

(1) The unswollen ovaries (Figs. 1 and 7) are observed in females without the breeding nests. The ovary is a Y-shaped narrow tubular organ lying ventro-medianly in the abdomen. The oogonia and the previtellogenic oocytes, less than about 40 μm in diameter, occur in 10-15 subspherical germaria which are arranged linearly in a germinal cord or a long ventro-median cumulus of the ovarian trunk. On the other hand, two forms of vitellogenic oocytes, early and late vitellogenic, occur on their respective stalks protruding in pairs

2) In the previous papers (MAKIOKA, 1968 and 1970), a division into Stages 6 and 7 was made for the convenience of description, but it seems better to unite both stages into a single stage, Stage 6, hereafter (Fig. 8).



Figs. 1-6. Diagrammatic representations of adult ovaries reconstructed from the transverse sections, showing a successive transition of morphological types. 1. Unswollen ovary, 2-3. Swollen ovaries in Stages 3 and 5, 4-6. Contracted ovaries in early, middle, and late Stage 6.
dE: degenerating ovarian epithelium, dES: degenerating egg-stalk, dN: degenerating nucleus, E: ovarian epithelium, EO: early vitellogenic oocyte, ES: egg-stalk, F: fatty yolk, FC: follicle cell, GC: germinal cord, L: ovarian lumen, LO: late vitellogenic oocyte, NE: new ovarian epithelium, NEO: new early vitellogenic oocyte, NL: new ovarian lumen, NLO: new late vitellogenic oocyte.

from each side of the germinal cord (the former) or of the ovarian trunk (the latter) into the body cavity.

The early vitellogenic oocytes with a few fatty yolk droplets remain about a regular 80 μm in diameter throughout the year. The late vitellogenic ones with a number of fatty yolk drops, however, show a remarkable seasonal size-variation from 150 to 300 μm in diameter with a change in the fatty yolk volume. The number of each form of vitellogenic oocytes is 20-30 in the ovary. The ovarian epithelial cells maintain a regular height of about 20 μm throughout the year.

(2) The swollen ovaries (Figs. 2, 3, and 8) are observed in females in the breeding nests during the first half of the embryo-breeding days. The ovary begins to swell with a synchronized growth of the ovarian epithelial cells secreting the nutritive materials at the time when the female begins to

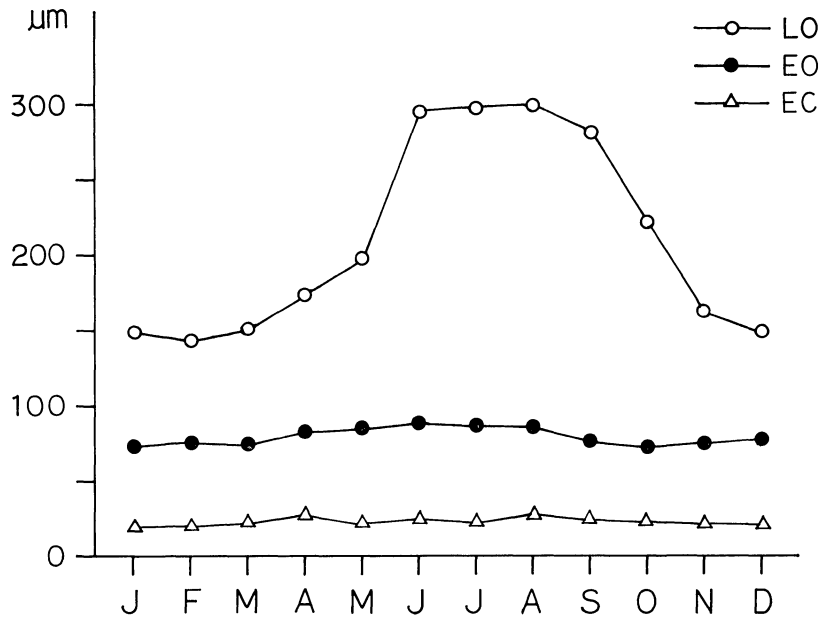


Fig. 7. Seasonal size-variations in oocytes (measured in diameter) and in ovarian epithelial cells (measured in height), based on monthly measurement for 3 years.
EC: ovarian epithelial cell, EO: early vitellogenic oocyte, LO: late vitellogenic oocyte.

construct the breeding nest. The growth of the ovarian epithelial cells lasts until the end of Stage 3. The cells then decrease remarkably in size with the complete release of the secretory materials into the ovarian lumen by the end of Stage 5. The ovary remains large in size and "swollen" in shape, retaining the secretory materials in the lumen.

The late vitellogenic oocytes are released from the swelling ovary (the oviposition) about a week after the initiation of breeding nest construction, although the early vitellogenic ones remain in the ovary without any indication of growth until the end of Stage 5.

(3) The contracted ovaries (Figs. 4-6, and 8) are observed in females in the breeding nests during the second half of the embryo-breeding days. The ovary becomes deflated by the rapid and complete release of the secretory materials from the ovarian lumen into the breeding sac containing the larvae

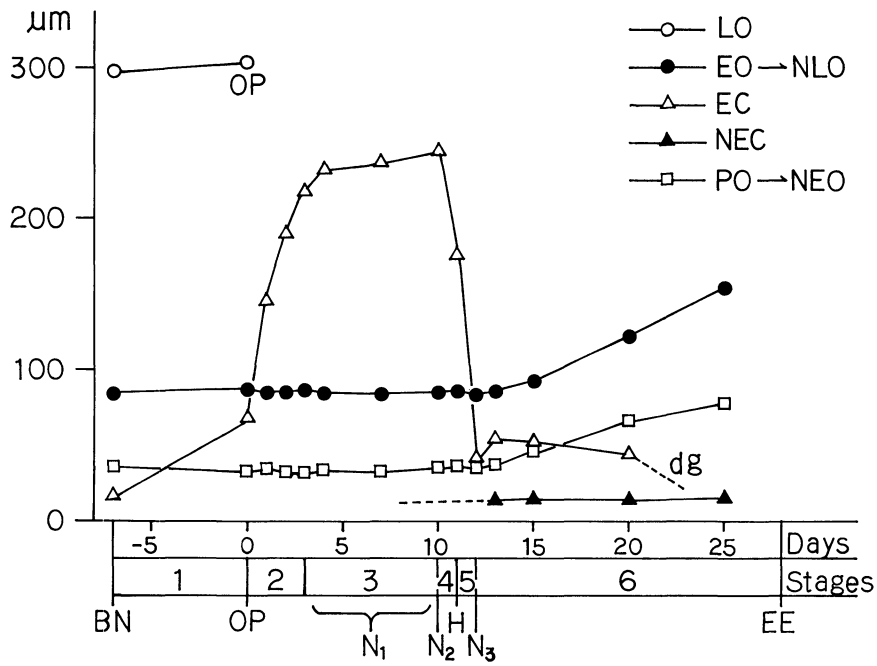


Fig. 8. Successive size-variations in oocytes (measured in diameter) and in ovarian epithelial cells (measured in height) during embryo-breeding.
BN: beginning of the breeding nest construction, dg: degeneration, EC: ovarian epithelial cell, EE: end of the embryo-breeding, EO: early vitellogenic oocyte, H: hatching, LO: late vitellogenic oocyte, N_1-N_2: supplies of the nutritive fluid for embryo, N_3: supply of the nutritive fluid for larva, NEC: new ovarian epithelial cell, NEO: new early vitellogenic oocyte, NLO: new late vitellogenic oocyte, OP: oviposition, PO: previtellogenic oocyte.

at the end of Stage 5, followed by degeneration of the ovarian epithelial cells which have completed the secretion.

The early vitellogenic oocytes grow into new late vitellogenic ones with a rapid fatty yolk deposition. At the same time, a pair of previtellogenic oocytes in each germarium develops into new early vitellogenic ones. They protrude, on their stalks, from each side of the germinal cord into the body cavity. A new ovarian epithelium is also formed from the dorsal part of the germinal cord, replacing the old one degenerating into several necrotic cellular masses. The new ovarian epithelial cells remain similar in size to those cells in the unswollen ovary.

Discussion

In the adult ovary of *Garypus japonicus*, the oogenic and the secretory functions occur alternatively and produce three morphological types. These peculiar patterns of occurrence of both functions can be summarized in terms of the ovarian functional phases as proposed below.

In the unswollen ovary, both functions seem to be entirely inhibited during the autumn and winter months (the resting phase) or almost entirely inhibited excepting the late vitellogenic process during the other months of the year (the preparatory phase). In the swollen ovary, the oogenic function seems to be inhibited and the secretory function is activated (the secretory phase). In the contracted ovary, the oogenic function is activated and the secretory function seems to be inhibited, while the ovarian epithelium is regenerated (the renovational phase).

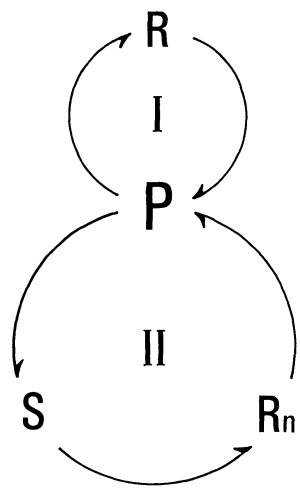


Fig. 9. Scheme of cycles of ovarian functional phases. In females which construct breeding nests, ovaries pass through Cycles I-II. In other females, however, ovaries pass through only Cycle I.
P: preparatory phase, R: resting phase, Rn: renovational phase, S: secretory phase.

The adult ovaries of *G. japonicus* alternate seasonally between the resting and the preparatory phases (Fig. 7) until, in the breeding season, the females

begin to construct the breeding nests in which the ovaries undergo successive transitions through the secretory and the renovational phases and approximate the preparatory phase again (Fig. 8).

The relations among the morphological types and among the functional phases are summarized in Figs. 1-6 and in Fig. 9, respectively.

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摘　　要

牧岡俊樹*（東京教育大学理学部付属臨海実験所，〒415 静岡県下田市5丁目10-1）：イソカニムシ成体卵巣における2機能の交代的発現。

1. イソカニムシ *Garypus japonicus* 成体卵巣の2つの主要な機能（卵形成機能および栄養液分泌機能）の発現のパターンが，卵母細胞および卵巣上皮細胞（分泌細胞）の両者をそれぞれの指標として，形態学的に追究された。
2. 成体卵巣は，未肥大，肥大，収縮の3つの基本的な形態を示した。これらの形態の相違は卵巣の両機能の発現のパターンすなわち卵巣の機能相の相違を反映していると考えられる。
3. 未肥大卵巣は哺育巣外の雌に限つて見出され，次の二つの機能相が認められる。秋から冬にかけての卵巣では両機能は完全に抑制されている（休止期）が，生殖時期（6—8月）にむかう卵巣では大型の卵母細胞における後期卵黄形成過程のみが活発化し，産卵の準備がととのう（準備期）。

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4. 肥大卵巣および収縮卵巣は哺育巣内の雌に限つて見出され，それぞれ次の２つの機能相に対応している。哺育巣内では，まず卵巣上皮細胞の栄養液分泌機能が活発化し卵巣は肥大するが，卵形成機能は抑制されている（分泌期）。すべての分泌物を胚および幼生に与え終ると卵巣は収縮し，分泌機能は停止する。分泌を終つた卵巣上皮は退化し，新上皮が再生する。卵形成機能は活発化し，卵巣は準備期の形態に近づく（更新期）。
5. これら４つの機能相において，卵巣の両機能は重複することなく交互に発現している。また，これらの機能相は一定の順序で周期的にくりかえされると考えられる。すなわち，胚哺育を行なわない場合には年１回の周期で休止期と準備期が交互に現われる。また，胚哺育を行なう場合には準備期から分泌期および更新期を経てふたたび準備期にもどり，生殖時期をすぎるとさらに休止期にもどる。